

Assessment of Mercury Emissions
From
The Incinerator Stack
at
Quirk Creek Sour Gas Plant

for

Energy Resources Conservation Board
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by

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March , 1987



THE INDUSTRIAL RESEARCH INSTITUTE
OF THE UNIVERSITY OF WINDSOR

SUMMARY

Five source sampling tests failed to confirm the high concentration of mercury that was determined once during a previous trace element emission study at the Esso-Quirk Creek sour gas plant. At the present time, the anomalous result can not be explained adequately.

A maximum emission rate of 0.50 ± 0.03 grams of mercury per hour has been estimated assuming that, under worst case conditions, mercury can be present in the incinerator stack emissions at limit of detection concentrations. Emission rates of mercury of this magnitude have been predicted for several other plants where the presence of the metal was not "established" since it was not "detected" in more than one-half of the tests or once at a concentration exceeding the limit of detection by a factor of three.

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1.0 BACKGROUND

Trace element emission studies involving twenty-nine metals have been carried out at ten selected sour gas plant incinerator stacks since 1982 (1, 2, 3). A total of thirty-five source sampling tests were conducted at the ten facilities. Mercury was found only once, on a filter, at a level defining definite presence after a test at the Esso-Quirk Creek complex. Since this detection of mercury represented an anomalous incinerator stack condition, the Energy Resources Conservation Board (ERCB) agreed that the Quirk Creek gas plant should be retested to determine whether the presence of mercury was "established" definitely in the incinerator stack emissions.

The objective and scope of this investigation were reviewed and defined during telephone conversations between Dr. H. Thimm of ERCB and Dr. S. Viswanathan of the Department of Chemical Engineering, University of Windsor.

2.0 OBJECTIVE

The basic objective of this study was to determine whether mercury was "consistently present" in the incinerator stack gases at the Esso-Quirk Creek sour gas plant.

3.0 SCOPE

Five complete particulate matter emission tests were conducted at the Quirk Creek facility using sampling procedures and equipment consistent with Alberta Environment requirements (4) or as mutually agreed to with Dr. H. Thimm of ERCB.

4.0 SOURCE SAMPLING METHODOLOGY

The source sampling procedures and equipment were identical to those used at the Quirk Creek gas plant during the earlier study (3).

5.0 SAMPLE RECOVERY

Samples were recovered from all parts of the sampling train according to procedures developed for previous sour gas plant incinerator stack sampling programs (1, 2, 3). One set of samples was preserved with potassium dichromate (10 mL of 5% $K_2Cr_2O_7$ per litre of solution).

6.0 ANALYTICAL PROCEDURES

The determination of mercury concentrations followed the analytical procedures developed for the earlier studies (1, 2, 3).

7.0 RESULTS

Five particulate matter sampling tests were conducted at the Esso Resources Canada Ltd.-Quirk Creek Gas Plant between November 15-17, 1986. All sample collection was carried out with borosilicate glass lined probes described in earlier publications (1, 2, 3).

Appendix I details the field data and isokineticity checks for the five tests.

Table 1 summarizes the laboratory recoveries of mercury from filters and liquids spiked with the twenty metals that were normally associated with the nitric acid solutions used for atomic absorption spectrometry (1, 2, 3).

Table 1: Per Cent Recoveries of Mercury From Nitric Acid Media

Laboratory Samples	Laboratory Recovery Test			
	1	2	3	4
Solutions	108	110		
Filters	93	99	95	94

According to Table 2, mercury concentrations in the four samples recovered from the sampling train Probe and Nozzle (P & N); Impingers 1, 2, 3 (Imp. 1, 2, 3); Impingers 4, 5 (Imp. 4, 5) and Filter after each test never exceeded limit of detection (LOD) values.

Table 2: Summary of Incinerator Stack Source Sampling Tests for Mercury at the Easo-Gulink Creek Gas Plant

Test	Sample From	P&N ug	Imp 1,2,3 ug	Imp 4,5 ug	Filter ug	Total Elemental Weight ug	Maximum Elemental Concentration ug/rcf	Possible Elemental Emission Rate g/h
1 Nov.15,1986		<4	<6	<5	<4	<19	<0.19	<0.50
2 Nov.15,1986		<5	<6	<4	<4	<19	<0.20	<0.47
3 Nov.16,1986		<5	<6	<6	<4	<21	<0.21	<0.55
4 Nov.16,1986		<5	<6	<5	<4	<20	<0.20	<0.50
5 Nov.17,1986 (sample preserved with K ₂ Cr ₂ O ₇)		<5	<6	<4	<4	<19	<0.19	<0.47

< Implies less than limit of detection value

8.0 DISCUSSION OF RESULTS

The recoveries of mercury from spiked liquids and filters ranged between 90% and 110%. Such results suggest that losses of mercury during analysis are not likely to occur.

The data in Table 2 indicate that mercury concentrations in the Quirk Creek incinerator stack gases did not meet the criteria that "establish" the definite presence of the metal. There was no difference between the amounts of mercury found in preserved and unpreserved samples recovered from the sampling train.

Emission rates of mercury have been calculated assuming that the metal could be present at concentrations equivalent to limit of detection values. They are comparable to emission rates of mercury estimated for a number of other plants (1, 2, 3).

9.0 CONCLUSIONS

On the basis of five source sampling tests carried out at the Esso-Quirk Creek sour gas plant it is evident that mercury concentrations in the gaseous emissions from the incinerator stack do not exceed limit of detection values. An average emission rate of 0.50 ± 0.03 g/h has been calculated assuming that, under worst case conditions, mercury can be present at limit of detection concentrations. Emission rates of mercury of this order of magnitude have been projected at several other plants (1, 2, 3).

It is clear that the single high mercury concentration determined in the gaseous effluents from the Quirk Creek incinerator stack (3) will remain an anomalous result that can not be explained adequately at this time.

REFERENCES

1. Gnyp, A.W., C.C. St. Pierre, D.S. Smith and S. Viswanathan, A Trace Element Emission Study at Selected Sour Gas Plant Incinerator Stacks in the Province of Alberta: Strachan - Gulf Oil Canada Limited, Ram River - Canterra Energy Limited, Jumping Pound - Shell Canada Limited, (1983) 171 page report, Industrial Research Institute of the University of Windsor, Windsor, Ontario, N9B 3P4.
2. Gnyp, A.W., C.C. St. Pierre, D.S. Smith and S. Viswanathan, A Trace Element Emission Study at Selected Sour Gas Plant Incinerator Stacks in the Province of Alberta: Waterton - Shell Canada Resources Limited, Pincher Creek-Gulf Oil Canada Limited, (1983) 151 page report, Industrial Research Institute of the University of Windsor, Windsor, Ontario, N9B 3P4.
3. Gnyp, A.W., C.C. St. Pierre, D.S. Smith and S. Viswanathan, A Trace Element Emission Study at Selected Sour Gas Plant Incinerator Stacks in the Province of Alberta: Harmattan - Canadian Superior Oil Limited, Nevis - Gulf Oil Canada Limited, Gold Creek - Petro Canada, Rainbow Lake - Canterra Energy Limited, Quirk Creek -Esso Resources Canada Limited, (1986) 204 page report, Industrial Research Institute of the University of Windsor, Windsor, Ontario, N9B 3P4.
4. Source Sampling Codes, Reference Methods for Source Sampling and Analysis of Particulates, Sulphur Oxides and Oxides of Nitrogen, Publication SSC-1176, Industrial Waste Management Branch, Standards and Approvals Division, Alberta Environment (1976).

APPENDIX I
FIELD SAMPLING DATA

- 1) CLIENT NAME: Energy Resources Conservation Board
LOCATION: Quirk Creek
COMPANY: Esso Resources Canada Ltd.
- 2) TEST NO: 1 DATE: Nov. 15, 1986
- 3) PRODUCTION: ---
- 4) BAROMETRIC PRESSURE: 29.39 (inches Hg)
STATIC PRESSURE: -2.1 (inches H₂O)
STACK DIMENSIONS: DIAMETER (D) 5 5/6 (feet)
- 5) PITOT TUBE COEFFICIENT: 0.794
METER CORRECTION FACTOR: 1.0
NOZZLE DIAMETER: 0.3125 (inches)
- 6) GAS COMPOSITION: (percent by volume)
CO₂ 3.2, O₂ 9.5, CO 0.0
SO₂ 0.2, N₂ 86.06, Ar 1.04
- 7) NO. OF READINGS: 42
TIME BETWEEN READINGS: 3.0 min.
TEST POINTS/TRVERSE: 10
NO. OF TRAVERSES: 2
- 8) CONDENSED WATER: 178.2 (grams)
WATER CAUGHT BY DRYING AGENTS: 12.3 (grams)
MOISTURE CONTENT, B_{WO}: 0.087
- 9) MOLECULAR WEIGHT OF GAS:
 29.844 DRY BASIS (lb_m/lb mole)
 28.817 WET BASIS (lb_m/lb mole)
- 10) VOLUME OF GAS SAMPLED: 97.30 (acfm)
- 11) AVERAGE STACK VELOCITY: 77.37 (ft/s) AVG.TEMP: 908.9 (°F)
AVERAGE VOLUMETRIC FLOW RATE: 124064 (acfm)

TABLE I.1 FIELD DATA SUMMARY SHEET

SAMPLE TIME (HOUR)	STAGE TEMP (DEG.F)	DELTA P (IN H2O)	VEL (FT/S)	DELTA H (IN H2O)	VOLUME (CUFT)	TEMP (DEG.F)	PHASE (OVER)	OUTLET (INLET)	IMPINGERS (INLET)	GLS (OUT)	GLS (IN)	PURP (VAC)	ISOKINETIC (VARIATION)
10	0.00	915	0.600	67.04	1.39	53.71	270	30	70	50	50	3.00	0.00
1	3.00	915	0.600	67.04	1.39	56.05	270	30	75	50	50	3.00	108.18
2	6.00	929	0.750	75.34	1.78	58.47	270	255	30	80	50	4.00	101.10
3	9.00	944	0.780	76.83	1.78	60.69	270	255	30	85	50	4.00	90.75
4	12.00	944	0.950	85.25	2.16	63.17	270	255	30	90	50	4.00	92.44
5	15.00	944	1.000	87.46	2.27	66.06	270	255	30	90	50	4.00	104.73
6	18.00	955	1.000	87.80	2.26	68.76	270	255	30	95	50	4.00	98.54
7	21.00	955	1.000	87.80	2.26	71.31	270	255	30	95	50	4.00	93.03
8	24.00	955	1.000	87.80	2.26	74.31	270	255	30	95	50	4.00	108.62
9	27.00	918	0.850	79.89	2.00	77.22	270	255	30	95	55	4.00	94.73
10	30.00	918	0.850	79.89	2.00	79.69	270	255	30	95	60	4.00	97.60
11	33.00	922	0.700	72.60	1.64	84.66	270	255	30	95	60	4.00	102.13
12	36.00	922	0.700	72.60	1.64	87.22	270	255	30	95	60	4.00	108.03
13	39.00	890	0.370	52.17	0.89	88.82	270	255	30	100	60	3.50	91.83
14	42.00	890	0.370	52.17	0.89	90.69	270	255	30	100	60	2.00	106.85
15	45.00	884	0.350	50.66	0.84	93.32	270	255	30	100	60	2.00	95.81
16	48.00	880	0.350	50.55	0.85	95.47	270	260	30	95	60	2.00	101.47
17	51.00	880	0.350	50.55	0.85	97.28	270	260	30	95	60	2.00	94.63
18	54.00	880	0.350	50.55	0.85	98.92	270	260	30	95	60	2.00	95.95
19	57.00	880	0.350	50.55	0.85	98.92	270	260	30	95	60	2.00	95.95
20	60.00	880	0.350	50.55	0.85	98.92	270	260	30	95	60	2.00	95.95

Table I.3: Field Sampling Data for Test #1, Esso-Quirk Creek, November, 15, 1986, Traverse #2

- 1) CLIENT NAME: Energy Resources Conservation Board
LOCATION: Quirk Creek
COMPANY: Esso Resources Canada Ltd.
- 2) TEST NO: 2 DATE: Nov. 15, 1986
- 3) PRODUCTION: ---
- 4) BAROMETRIC PRESSURE: 29.39 (inches Hg)
STATIC PRESSURE: -2.1 (inches H₂O)
STACK DIMENSIONS: DIAMETER (D) 5 5/6 (feet)
- 5) PITOT TUBE COEFFICIENT: 0.794
METER CORRECTION FACTOR: 1.0
NOZZLE DIAMETER: 0.3125 (inches)
- 6) GAS COMPOSITION: (percent by volume)
CO₂ 3.5, O₂ 9.0, CO 0.0
SO₂ 0.22, N₂ 86.24, Ar 1.04
- 7) NO. OF READINGS: 42
TIME BETWEEN READINGS: 3.0 min.
TEST POINTS/TRVERSE: 10
NO. OF TRAVERSES: 2
- 8) CONDENSED WATER: 250.1 (grams)
WATER CAUGHT BY DRYING AGENTS: 14.7 (grams)
MOISTURE CONTENT, B_{wo}: 0.118
- 9) MOLECULAR WEIGHT OF GAS:
29.78 DRY BASIS (lb_m/lb mole)
28.39 WET BASIS (lb_m/lb mole)
- 10) VOLUME OF GAS SAMPLED: 92.13 (acf)
- 11) AVERAGE STACK VELOCITY: 72.2 (ft/s) AVG. TEMP: 907.4°F
AVERAGE VOLUMETRIC FLOW RATE: 115818 (acfm)

TABLE II.1 FIELD DATA SUMMARY SHEET

SAMPLE POINT (NO)	TIME (MIN)	STACK TEMP (DEG F)	DELTA P (IN H2O)	VEL (FT/S) (IN H2O)	DELTA M (IN H2O)	GAS METER VOLUME (CUBT)	PROBE	TEMP (DEG F)	OVER	OUTLET INLET	IMPINGERS INLET OUT	GAS METER IN	DEG F	PURP VIC (IN NG)	ISOTHERMIC VARIATION (PERCENT)
10	0.00	916	0.500	61.55	1.17	226.20	270	270	240	30	70	55	55	2.00	0.00
10	3.00	916	0.500	61.55	1.17	228.21	270	270	240	30	70	55	55	2.00	103.57
9	6.00	915	0.600	67.55	1.40	230.14	270	270	245	30	75	55	55	2.00	91.42
9	9.00	915	0.600	67.55	1.40	232.29	270	270	245	30	75	55	55	2.00	101.41
8	12.00	915	0.600	67.55	1.40	234.34	270	270	245	30	80	55	55	2.50	96.39
8	15.00	917	0.600	67.80	1.40	236.34	270	270	245	30	85	55	55	2.50	95.57
7	18.00	917	0.800	78.05	1.40	238.95	270	270	245	30	85	55	55	2.50	105.88
7	21.00	920	0.800	78.14	1.40	241.28	270	270	245	30	85	55	55	2.50	95.13
6	24.00	920	0.850	80.40	1.40	243.67	270	270	245	30	90	55	55	3.00	97.89
5	27.00	915	1.000	87.20	1.47	245.97	270	270	250	30	95	60	60	3.50	91.14
5	30.00	915	1.000	87.11	1.47	248.89	270	270	255	30	95	60	60	3.50	105.83
5	33.00	912	1.050	89.26	1.30	251.51	270	270	255	35	100	60	60	3.00	94.75
4	36.00	912	1.050	89.26	1.30	254.24	270	270	255	35	100	60	60	3.00	96.02
3	39.00	921	0.500	61.80	1.17	257.17	270	270	255	35	105	60	60	3.00	103.34
3	42.00	921	0.500	61.80	1.17	259.27	270	270	255	35	105	60	60	3.00	107.62
3	45.00	921	0.500	61.10	0.72	261.14	270	270	255	35	105	60	60	3.00	95.85
2	48.00	890	0.500	61.10	0.72	263.30	270	270	260	35	105	60	60	2.00	109.32
2	51.00	890	0.500	61.10	0.72	265.25	270	270	260	35	105	60	60	2.00	98.71
1	54.00	890	0.500	61.10	0.72	267.32	270	270	260	35	105	60	60	2.00	105.05
1	57.00	890	0.500	61.10	0.72	269.45	270	270	260	35	105	60	60	2.00	107.58
1	60.00	890	0.500	61.10	0.72	271.42	270	270	260	35	105	60	60	2.00	100.04

Table II.2: Field Sampling Data for Test #2, Esso-Quirk Creek, November, 15, 1986, Traverse #1

SAMPLE POINT (NO)	TIME (MIN)	STACK TEMP DEG.F	DELTA P (IN H2O)	VLL (FT/S)	DELTA H (IN H2O)	VOLUME (CUFT)	PROBE	TEMP (DEG.F)	OVER	OUTLET INLET	IMPINGERS GAS INLET	OUT IN	PUMP VAC (IN HG)	ISOKINETIC VARIATION (PERCENT)
10	0-00	990	0.500	61.10	0.75	271.42	270	250	250	30	70	45	3-00	0-00
10	3-00	890	0.500	61.10	0.75	273.19	270	250	250	30	75	45	3-00	92.01
9	6-00	990	0.550	64.08	1.28	275.03	270	250	250	30	75	45	3-00	91.72
9	9-00	990	0.550	64.08	1.28	277.08	270	250	250	30	85	45	4-00	102.19
8	12-00	905	0.650	70.05	1.51	279.42	270	250	250	30	85	45	4-00	107.41
8	15-00	905	0.650	70.05	1.51	281.72	270	250	250	30	90	45	4-00	105.97
7	18-00	910	0.850	80.25	1.95	284.38	270	250	250	30	95	45	4-00	107.27
7	21-00	910	0.850	80.25	1.95	287.10	270	250	250	30	100	45	4-00	109.82
6	24-00	906	0.950	84.72	2.21	289.57	270	250	250	30	105	50	4-50	93.47
6	27-00	906	0.950	84.72	2.21	292.01	270	250	250	30	110	50	4-50	92.41
5	30-00	918	1.000	87.17	2.31	294.53	270	250	250	30	110	50	5-00	93.19
5	33-00	914	1.050	89.32	2.42	297.51	270	250	250	30	115	50	5-00	107.48
4	36-00	934	1.050	89.97	2.40	300.43	270	250	250	30	115	50	6-00	106.11
4	39-00	934	1.050	89.97	2.40	303.44	270	250	250	30	115	50	6-00	109.36
3	42-00	921	0.850	80.57	1.96	305.96	270	250	250	30	115	50	5-00	101.15
3	45-00	910	0.720	73.86	1.66	308.32	270	250	250	30	115	50	5-00	102.62
2	48-00	910	0.720	73.86	1.66	310.75	270	255	255	30	115	50	5-00	105.47
2	51-00	905	0.500	61.44	1.17	312.85	270	255	255	30	115	50	4-00	109.11
1	54-00	890	0.500	61.10	1.18	314.89	270	255	255	30	115	50	3-50	105.49
1	57-00	890	0.450	57.96	1.06	316.56	270	255	255	30	115	50	3-50	90.87
1	60-00	890	0.450	57.96	1.06	318.32	270	255	255	30	115	50	3-50	95.82

Table II.3: Field Sampling Data for Test #2, Esso-Quirk Creek, November, 15, 1986, Traverse #2

SAMPLE POINT (NO)	TIME (H:M)	STACK TEMP (DEG F)	DELTA P (IN H2O)	VEL (FT/S) (IN H2O)	DELTA N (IN H2O)	VOLUME (CUFT)	PROBE	TEMP (DEG F)	OVER	OUTLET INLET	IMPINGERS (GAS METER OUT IN)	PURP VAC (IN HG)	ISOKINETIC VARIATION (PERCENT)
10	0.00	89C	0.400	54.35	0.34	365.23	260	285	250	30	45	1.00	0.00
10	3.00	890	0.400	54.35	0.57	366.76	260	250	250	30	45	1.00	90.35
9	6.00	894	0.400	54.87	0.90	368.31	260	250	250	30	55	1.00	92.15
9	9.00	896	0.470	59.04	1.06	370.13	260	250	250	30	70	1.50	99.57
8	12.00	900	0.700	72.16	1.57	372.55	260	250	250	30	70	2.50	108.71
8	15.00	900	0.850	79.52	1.91	374.76	260	250	250	30	80	4.00	90.14
7	18.00	900	1.050	88.38	2.41	377.40	260	250	250	30	90	4.00	95.17
7	21.00	920	1.050	106.45	2.37	379.94	260	250	250	30	100	4.00	92.59
6	24.00	921	1.500	106.45	3.38	382.19	260	250	250	30	120	4.20	98.94
6	27.00	921	1.500	106.45	3.38	384.48	260	250	250	30	130	5.00	100.44
5	30.00	917	1.700	113.16	3.84	389.69	260	250	250	30	130	5.50	91.97
5	33.00	925	1.500	106.60	3.38	396.72	260	250	250	30	130	5.50	107.88
4	36.00	925	1.500	106.60	3.38	400.19	260	250	250	30	130	5.50	99.50
4	39.00	925	1.500	97.14	3.05	403.14	260	250	250	30	125	5.50	106.09
3	42.00	874	1.300	97.40	3.04	406.18	260	250	250	30	125	5.50	101.02
3	45.00	869	0.700	97.22	1.66	409.26	260	250	250	30	125	5.50	91.33
2	48.00	865	0.620	71.34	1.01	411.72	260	250	250	30	125	5.50	98.75
1	51.00	867	0.420	55.07	1.01	413.70	260	250	250	30	120	5.00	106.21
1	54.00	860	0.420	55.07	1.01	415.41	260	250	250	30	120	5.00	90.52
1	57.00	86C	0.420	55.07	1.01	417.07	260	250	250	30	120	4.00	94.37
1	60.00	86C	0.420	55.07	1.01	417.07	260	250	250	30	120	4.00	91.55

Table III.2: Field Sampling Data for Test #3, Esso-Quirk Creek, November, 16, 1986, Traverse #1

(SAMPLE TIME)	STACK	DELTA P	VEL	(DELTA H)	(GAS METER)	TEMP	PROBE	OVER	OUTLET	IMPINGERS	(GAS METER)	PUMP	(ISOKINETIC)
(POINT)	(NO)	(IN H2O)	(FT/S)	(IN H2O)	(CUFT)	(DEG F)			INLET	OUT	IN	(IN HG)	(PERCENT)
10	0.001	967	0.500	1.18	417.07	270	270	240	30	90	47	2.00	0.00
10	3.001	876	0.500	1.18	419.10	270	270	240	30	95	47	2.00	103.00
9	6.001	886	0.700	1.67	421.42	270	270	240	30	95	48	3.50	100.06
9	9.001	886	0.700	1.67	423.72	270	270	240	30	95	48	3.50	99.15
8	12.001	892	0.820	1.93	426.11	270	270	250	30	100	50	4.50	93.28
8	15.001	892	0.820	1.93	428.58	270	270	255	30	105	50	5.00	99.73
7	18.001	909	0.870	2.02	431.14	270	270	260	30	110	50	5.50	99.71
7	21.001	927	0.940	2.20	433.81	270	270	265	30	110	50	6.00	96.30
6	24.001	921	1.070	2.47	436.54	270	270	265	30	115	50	6.00	92.19
6	27.001	921	1.070	2.47	439.15	270	270	265	30	120	50	6.00	90.71
5	30.001	937	0.850	1.93	441.44	270	270	265	30	125	50	6.00	101.00
5	33.001	937	0.850	1.93	443.99	270	270	265	30	115	50	6.00	102.92
4	36.001	918	0.820	1.89	446.56	270	270	265	30	115	50	6.00	102.93
4	39.001	918	0.820	1.89	449.13	270	270	265	30	115	50	6.00	97.26
3	42.001	901	0.700	1.64	451.39	270	270	265	30	115	50	4.00	104.61
3	45.001	901	0.700	1.64	453.82	270	270	265	30	115	52	3.50	96.87
2	48.001	892	0.520	1.24	455.77	270	270	265	30	105	52	3.00	100.56
2	51.001	892	0.520	1.24	457.80	265	265	260	30	105	52	3.00	108.30
1	54.001	890	0.400	0.95	459.72	265	265	260	30	105	52	3.00	93.06
1	57.001	890	0.400	0.95	461.37	265	265	260	30	105	52	3.00	105.81
1	60.001	890	0.400	0.95	463.25	265	265	260	30	105	52	3.00	105.81

Table III.3: Field Sampling Data for Test #3, Esso-Quirk Creek, November, 16, 1986, Traverse #2

- 1) CLIENT NAME: Energy Resources Conservation Board
LOCATION: Quirk Creek
COMPANY: Esso Resources Canada Ltd.
- 2) TEST NO: 4 DATE: Nov. 16, 1986
- 3) PRODUCTION: ---
- 4) BAROMETRIC PRESSURE: 29.54 (inches Hg)
STATIC PRESSURE: -2.1 (inches H₂O)
STACK DIMENSIONS: DIAMETER (D) 5 5/6 (feet)
- 5) PITOT TUBE COEFFICIENT: 0.794
METER CORRECTION FACTOR: 1.0
NOZZLE DIAMETER: 0.3125 (inches)
- 6) GAS COMPOSITION: (percent by volume)
CO₂ 4.0, O₂ 8.5, CO 0.0
SO₂ 0.25, N₂ 86.2, Ar 1.04
- 7) NO. OF READINGS: 42
TIME BETWEEN READINGS: 3.0 min.
TEST POINTS/TRVERSE: 10
NO. OF TRAVERSES: 2
- 8) CONDENSED WATER: 166.3 (grams)
WATER CAUGHT BY DRYING AGENTS: 22.1 (grams)
MOISTURE CONTENT, B_{wo}: 0.083
- 9) MOLECULAR WEIGHT OF GAS:
29.74 DRY BASIS (lb_m/lb mole)
28.77 WET BASIS (lb_m/lb mole)
- 10) VOLUME OF GAS SAMPLED: 95.72 (acf)
- 11) AVERAGE STACK VELOCITY: 72.8 (ft/s) AVG. TEMP: 903.8(°F)
AVERAGE VOLUMETRIC FLOW RATE: 116751 (acfm)

TABLE IV.1 FIELD DATA SUMMARY SHEET

SAMPLE POINT (NO)	TIME (MIN)	STACK TEMP (DEG F)	DELTA P (IN H ₂ O)	VEL (FT/S)	DELTA H (IN H ₂ O)	GAS METER VOLUME (CUFT)	PROBE	TEMP (DEG F)	OVER	IMPIGERS OUTLET INLET	GAS METER IN OUT	PREP VAC (IN HG)	ISOKINETIC VARIATION (PERCENT)
10	0.00	883	0.450	57.29	0.58	500.52	260	250	250	30	55	40	0.00
10	3.00	885	0.450	57.33	0.58	502.33	260	250	250	30	65	40	97.17
9	6.00	892	0.600	66.37	0.74	504.32	260	250	250	30	90	40	93.06
9	9.00	900	0.600	66.57	0.85	506.54	260	250	250	30	95	40	101.78
8	12.00	913	0.750	74.78	1.02	509.04	260	250	250	30	100	40	105.10
8	15.00	913	0.750	74.78	1.02	511.33	260	250	250	30	100	40	96.58
7	18.00	917	0.800	77.34	1.13	513.44	260	250	250	30	105	40	92.65
7	21.00	918	0.800	77.37	1.13	515.22	260	250	250	30	105	40	92.65
6	24.00	943	0.870	81.42	1.49	518.28	260	250	250	30	110	40	93.00
6	27.00	943	0.850	80.47	1.67	520.90	260	245	245	30	110	40	104.11
5	30.00	943	1.000	87.29	1.60	523.86	260	250	250	30	120	50	107.67
5	33.00	939	1.050	89.31	1.64	526.95	260	250	250	30	130	50	104.97
4	36.00	931	0.950	84.71	2.17	529.78	260	250	250	30	130	50	104.78
4	39.00	936	0.950	84.86	2.17	532.70	260	250	250	30	130	50	107.96
3	42.00	929	1.100	91.09	2.52	535.74	260	250	250	30	140	50	104.70
3	45.00	920	1.150	92.43	2.65	538.42	260	250	250	30	140	50	96.52
2	48.00	910	0.720	73.19	1.67	541.02	260	250	250	30	130	50	101.09
2	51.00	896	0.560	64.22	1.31	543.06	260	250	250	30	130	50	96.83
1	54.00	890	0.420	55.49	0.99	544.75	260	250	250	30	130	50	92.28
1	57.00	890	0.420	55.49	0.99	546.45	260	250	250	30	130	50	103.85
1	60.00	890	0.420	55.49	0.99	548.52	260	250	250	30	103	50	103.22

Table IV.2: Field Sampling Data for Test #4, Esso-Quirk Creek, November, 16, 1986, Traverse #1

SAMPLE TIME POINT (MO)	TIME (:MM)	STACK TEMP DEG.F	DELTA P (IN H2O)	VLL (PT/3)	DELTA H (IN H2O)	VOLUME (CUFT)	PROBE	TEMP OVER	A OUTLET	IMPINGERS INLET	S OUT	ISOTHERMIC VAC (IN HG)	ISOTHERMIC VARIATION (PERCENT)
10	0-00	881	0.450	57.25	1.12	548.52	265	270	30	70	50	3-50	0-00
10	3-00	883	0.480	59.17	1.14	550.42	265	270	30	75	50	3-50	97.03
9	6-00	899	0.500	60.75	1.18	552.42	265	270	30	90	50	4-00	100.47
9	9-00	896	0.500	60.68	1.18	554.47	265	270	30	110	50	4-50	102.77
8	12-00	910	0.620	67.92	1.44	556.59	265	270	30	120	50	5-50	96.54
8	15-00	910	0.640	69.00	1.44	558.70	265	275	30	125	50	6-00	94.28
7	18-00	943	0.850	80.47	1.48	561.17	265	275	30	130	50	6-00	96.80
7	21-00	937	0.850	80.30	1.70	563.53	265	275	30	120	50	6-50	92.30
6	24-00	935	0.900	82.57	1.59	566.23	265	275	30	120	50	6-50	102.46
6	27-00	930	0.980	86.01	1.56	569.13	265	275	30	110	50	6-00	105.22
5	30-00	922	1.000	86.63	1.73	572.11	265	275	30	110	50	6-00	107.31
5	33-00	922	1.000	86.63	1.73	572.11	265	275	30	110	50	6-00	96.86
4	36-00	872	1.000	85.05	1.66	577.49	265	270	30	110	45	5-00	95.42
4	39-00	866	0.900	80.50	1.66	580.18	265	270	30	110	45	5-00	100.73
3	42-00	864	0.950	82.65	1.78	583.08	265	270	30	110	45	5-50	105.58
3	45-00	864	0.950	82.65	1.78	586.02	265	270	30	110	45	5-50	106.90
2	48-00	861	0.650	68.29	1.56	588.09	265	270	30	110	45	5-00	91.19
2	51-00	872	0.650	68.57	1.54	590.47	265	270	30	110	45	5-00	104.95
1	54-00	876	0.420	55.08	0.99	592.46	265	270	30	110	45	3-50	109.06
1	57-00	870	0.420	55.08	0.99	594.47	265	270	30	110	45	3-50	109.76
1	60-00	870	0.420	55.08	0.99	596.24	265	270	30	110	45	3-50	96.94

Table IV.3: Field Sampling Data for Test #4, Esso-Quirk Creek, November, 16, 1986,
Traverse #2

- 1) CLIENT NAME: Energy Resources Conservation Board
LOCATION: Quirk Creek
COMPANY: Esso Resources Canada Ltd.
- 2) TEST NO: 5 DATE: Nov. 17, 1986
- 3) PRODUCTION: ---
- 4) BAROMETRIC PRESSURE: 29.9 (inches Hg)
STATIC PRESSURE: -2.2 (inches H₂O)
STACK DIMENSIONS: DIAMETER (D) 5 5/6 (feet)
- 5) PITOT TUBE COEFFICIENT: 0.794
METER CORRECTION FACTOR: 1.0
NOZZLE DIAMETER: 0.3125 (inches)
- 6) GAS COMPOSITION: (percent by volume)
CO₂ 3.0, O₂ 8.0, CO 0.0
SO₂ 0.30, N₂ 87.6, Ar 1.06
- 7) NO. OF READINGS: 42
TIME BETWEEN READINGS: 3.0 min.
TEST POINTS/TRVERSE: 10
NO. OF TRAVERSES: 2
- 8) CONDENSED WATER: 229.6 (grams)
WATER CAUGHT BY DRYING AGENTS: 19.2 (grams)
MOISTURE CONTENT, B_{wo}: 0.108
- 9) MOLECULAR WEIGHT OF GAS:
29.64 DRY BASIS (lb_m/lb mole)
28.38 WET BASIS (lb_m/lb mole)
- 10) VOLUME OF GAS SAMPLED: 91.11 (acf)
- 11) AVERAGE STACK VELOCITY: 74.1 (ft/s) AVG. TEMP: 908.9°F
AVERAGE VOLUMETRIC FLOW RATE: 118771 (acfm)

SAMPLE TIME POINT (NO)	STACK TEMP DEG.F	DELTA P (IN H2O)	VEL (FT/S)	DELTA H (IN H2O)	VOLUME (CUFT)	TEMP DEG.F	PROBE	OVER	ISPIRERS OUTLET	ISPIRERS INLET	GAS OUT	GAS IN	PUMP VAC (IN HG)	ISOKINETIC VARIATION (PERCENT)
10	0.001	881	0.700	1.60	652.05	270	270	260	25	50	28	30	1.50	0.00
10	3.001	884	0.700	1.60	654.37	270	270	260	25	55	28	30	1.50	103.17
9	6.001	891	0.850	1.92	656.61	270	270	260	25	60	30	30	1.50	92.27
9	9.001	886	0.850	1.93	659.13	270	270	260	25	62	30	30	2.50	103.73
8	12.001	891	1.300	2.94	661.91	270	270	260	25	65	30	32	3.50	92.43
8	15.001	890	1.300	2.94	664.94	270	270	260	25	70	30	32	4.00	100.96
7	18.001	934	1.500	3.33	667.92	270	270	260	25	75	30	35	4.00	93.85
7	21.001	934	1.500	3.33	671.05	270	270	260	25	75	30	35	8.00	98.42
6	24.001	924	0.820	1.38	673.29	270	270	260	25	80	30	35	3.50	94.42
6	27.001	927	0.820	1.38	675.70	270	270	260	25	85	30	35	3.50	101.85
5	30.001	928	0.800	1.33	678.07	270	270	260	25	90	30	35	3.50	101.30
5	33.001	918	0.850	1.45	680.28	270	270	260	25	90	30	35	3.50	91.16
4	36.001	889	0.720	1.72	682.45	270	270	260	25	95	30	35	3.50	96.51
4	39.001	884	0.750	1.72	684.74	270	270	260	25	100	30	35	3.50	99.60
3	42.001	887	0.780	1.78	687.11	270	270	260	25	100	30	35	3.50	101.20
3	45.001	926	0.470	1.49	689.14	270	270	260	25	105	30	35	3.50	95.14
2	48.001	922	0.450	1.45	691.06	270	270	260	25	105	32	35	3.50	90.46
2	51.001	920	0.450	1.47	693.28	270	270	270	30	100	35	38	3.50	104.19
1	54.001	885	0.540	1.25	695.37	270	270	270	30	100	35	38	3.50	106.40
1	57.001	885	0.520	1.25	697.46	270	270	270	30	100	35	38	2.00	108.21
1	60.001	872	0.510	1.25	699.50	270	270	270	30	100	35	39	2.00	106.18

Table V.2: Field Sampling Data for Test #5, Esso-Quirk Creek, November, 17, 1986,
Traverse #1

SAMPLE TIME POINT (MO)	STACK TEMP DEG.F	DELTA P (IN W20)	VEL (FT/S) (IN W20)	(DELTA W (GAS METER VOLUME (CUFT)	T E A P E PROCE OVEN	A T O R E S INPIMERS GAS METER OUTLET INLET OUT IN	PUMP VAC (IN HG)	ISOKINETIC VARIATION (PERCENT)	
10	0.00	976	57.18	699.50	265	270	35	1.00	0.00
10	3.00	881	57.29	701.22	265	270	35	1.00	95.77
9	6.00	924	52.77	702.89	265	270	35	1.00	104.25
9	9.00	920	52.70	704.63	265	270	35	1.50	107.92
8	12.00	927	72.66	707.03	265	270	35	2.50	109.27
8	15.00	930	72.74	709.04	265	270	35	2.50	91.52
7	18.00	934	72.85	711.35	265	270	35	2.50	103.34
7	21.00	934	72.85	713.67	265	270	35	2.50	105.79
6	24.00	946	87.50	716.18	265	270	38	2.50	95.47
6	27.00	945	87.41	718.92	265	270	40	2.50	104.30
5	30.00	933	87.22	721.62	265	270	40	2.50	102.35
5	33.00	928	86.88	724.15	265	270	40	2.50	95.40
4	36.00	921	75.05	726.58	265	270	40	2.50	91.26
4	39.00	907	66.23	728.96	265	270	40	2.00	103.35
3	42.00	907	66.23	731.19	265	270	40	2.00	108.94
3	45.00	907	66.23	733.09	265	270	40	2.00	92.24
2	48.00	907	66.23	735.00	265	270	40	2.00	92.95
2	51.00	886	65.72	737.09	270	260	40	2.00	100.94
1	54.00	890	60.59	739.14	270	260	40	2.00	107.53
1	57.00	890	60.59	741.20	270	260	40	2.00	108.56
1	60.00	890	60.59	743.16	270	260	40	2.00	102.67

Table V.3: Field Sampling Data for Test #5, Esso-Quirk Creek, November, 17, 1986,
Traverse #2